5.16.19 AIR CONTENT OF FRESH CONCRETE BY THE VOLUMETRIC METHOD
(Kansas Test Method KT-19)

a. SCOPE

This method of test covers the procedure for determining the air content of freshly mixed concrete. It is applicable to concrete containing normal, dense, light weight or cellular aggregate. KT-19 reflects testing procedures found in AASHTO T 196.

b. REFERENCED DOCUMENTS

b.1. KT-17; Sampling Fresh Concrete

b.2. KT-20; Mass Per Cubic Meter (Foot), Yield Cement Factor and Air Content (Gravimetric) of Fresh Concrete

b.3. AASHTO T 196; Air Content of Freshly Mixed Concrete By the Volumetric Method

c. APPARATUS

c.1. Air meter consisting of a bowl and top section meeting the following requirements.

c.1.a. Bowl: The bowl shall be constructed of sufficient thickness and rigidity to withstand normal field use and resistant to attack by cement paste. The bowl shall have a diameter equal to 1 to 1.25 times the height and be constructed with a flange at or near the top surface. The bowl will have a capacity of not less than 0.002 m^3 (0.075 ft^3).

c.1.b. Top Section: The top section shall be constructed of material of sufficient thickness and rigidity to withstand normal field use and resistant to attack by cement paste. The top section shall have a capacity at least 20 % larger than the bowl and shall be equipped with a flexible gasket and with hooks or lugs to attach to the flange on the bowl to make a watertight connection. The top section shall be equipped with a glasslined or transparent plastic neck, graduated in increments not greater than 0.5% from 0 at the top to 9%, or more, of the volume of the bowl. Graduations shall be accurate to ± 0.1% by volume of the bowl. The upper end of the neck shall be threaded and equipped with a screw cap having a gasket to make a watertight fit.

c.2. Metal funnel with a spout of a size permitting it to be inserted through the neck on the top section and long enough to extend to a point just above the top of the bottom section. The discharge end of the spout shall be so constructed that when water is added to the container there will be a minimum disturbance of the concrete.

c.3. Tamping rod shall be a straight steel rod, 16 mm (5/8 in) in diameter and approximately 300 mm (12 in) in length with both ends rounded to a hemispherical tip of the same diameter

c.4. Strike-off bar a flat, straight steel bar at least 3 by 20 by 300 mm (1/8 by 3/4 by 12 in) or a flat, straight bar at least 6 by 20 by 300 mm (0.23 by 0.75 by 12 in) high density polyethylene or other plastic of equal or greater abrasion resistance.

c.5. Glass plate[1].

c.6. Measuring cup having a capacity equal to 1.03 ± 0.04 percent of the volume of the bowl of the air meter.

c.7. Rubber bulb syringe having a capacity at least that of the measuring cup.

c.8. Pouring vessel of suitable capacity.

c.9. Trowel.

c.10. Small metal scoop.

c.11. Mallet with rubber or rawhide head weighing approximately 0.57 ± 0.23 kg (1.25 ± 0.50 lb) for use with measures of 0.014 m^3 (0.5 ft^3) or smaller, and a mallet weighing approximately 1.02 ± 0.23 kg (2.25 ± 0.50 lb) for use with measures larger than 0.014 m^3 (0.5 ft^3).

c.12. Isopropyl Alcohol: Use 70% by volume isopropyl alcohol[a,b] (approximately 65% by mass).

NOTE a: The volume of the measuring cup is slightly larger than 1.0% of the volume of the bowl to compensate for the volume contraction that takes place when 70% isopropyl alcohol is mixed with water. Other alcohol or defoaming agents may be used if calculations show that their use will result in an error in indicated air content less than 0.1%.

NOTE b: 70% isopropyl alcohol is commonly available as rubbing alcohol. More concentrated grades can be diluted with water to the required concentration.

d. CALIBRATION OF APPARATUS

d.1. Determine the volume of the bowl of the air meter, in cubic meters (feet), as outlined in **KT-20**, by accurately weighing the amount of water required to fill the bowl, and dividing this mass by the unit weight of water at the same temperature (see KT-15). Use a glass plate to cover the bowl to remove excess water and to ensure that the container is full.

d.2. Determine the accuracy of the graduations on the neck of the top section of the air meter by filling the assembled measuring bowl and top section with water to a preselected air content graduation and then determining the quantity of 21.1°C (70°F) water required to fill the meter to the zero mark. The quantity of water added shall equal the preselected air content graduation within ± 0.1 volume percent of the measuring bowl. Repeat the procedure to check a minimum of 3 graduations within the expected range of use.

d.3. Determine the volume of the measuring cup using water at 21.1°C (70°F) by the method outlined in **d.2.** A quick check can be made by adding 1 or more cups of water to the assembled apparatus and observing the increase in the height of the water column after filling to a given level as described in **d.2.**

[1] AASHTO T 196 uses only a straight edge to level the top of the bowl. The glass plate ensures the volume of the bowl is properly filled with visual confirmation.

e. TEST PROCEDURE

e.1. Obtain a sample of fresh concrete in accordance with **KT-17**.

e.2. Place three equal layers of concrete in the bowl.

e.2.a. Rod each layer 25 times. When rodding the first layer, avoid striking bottom of the container and, when rodding successive layers, use only enough force to penetrate the surface of the underlying layer.

e.2.b. After each layer is rodded, tap the sides of the measure 10 to 15 times smartly with the mallet to close any voids left by the tamping rod and to release any large bubbles of air that may have been trapped.

e.3. Strike off the excess concrete, level full, with the strike-off bar or a glass plate. Thoroughly clean the flanges of the bowl and cover to ensure an air tight fit.

e.4. Clamp the top section into position on the bowl, insert the funnel, and add water until it appears in the neck. Remove the funnel and adjust the water level, using the rubber syringe, until the bottom of the meniscus is level with the zero mark[c,d]. Attach and tighten the screw cap.

NOTE c: For low slump or sticky mixes, a small diameter metal rod suitably bent may be used to break up the concrete before the cap is placed on the apparatus[2].

NOTE d: When filling the air meter with water, the addition of a minimum of 500 mL (1pt) of alcohol facilitates the removal of air from **high** air content or **high** cement content concretes, or mixtures with midrange water reducers.

e.5. Invert and agitate the unit until the concrete settles free from the base; and then, with the neck elevated, roll and rock the unit until the air appears to have been removed from the concrete. Set the apparatus upright, jar it lightly, and allow it to stand until the air rises to the top. Repeat the operation until no further drop in the water column is observed.

e.6. When all the air has been removed from the concrete and allowed to rise to the top of the apparatus, remove the screw cap. Add, in small increments, one measuring cupful of isopropyl alcohol, using the syringe to dispel the foamy mass on the surface of the water.

e.7. Make a direct reading of the liquid in the neck, reading to the bottom of the meniscus, and estimating to the nearest 0.25 percent.

f. CALCULATIONS

f.1. Calculate the air content of the concrete in percent by adding to the reading from **e.7.** the amount of alcohol used in accordance with **e.6.** An example would be determining the air content reading to be 5.7% and 1.0% of alcohol was used (one cup full). The total air content would be 6.7%.

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[2] This technique is not found in AASHTO T 196. It does permit the material to break up quicker when dealing with low slump or sticky mixes.

g. CALCULATION OF YIELD CEMENT FACTOR

The Yield Cement Factor of a concrete sample can be calculated using the Design Cement Factor, the Design Percent Air and the Actual or Measured Percent Air.

g.1. Actual YCF (with measured air content GREATER than design).

$$= \frac{\text{Design YCF}}{1 + \dfrac{(\text{measured \% air - design \% air})}{100}}$$

g.2. Actual YCF (with measured air content LESS than design).

$$= \frac{\text{Design YCF}}{1 - \dfrac{(\text{design \% air - measured \% air})}{100}}$$

g.3. When the measured percent air is higher than the design percent air, the volume of aggregate, water and cement will be less than the designed volumes within 0.95 m^3 (1 yd^3). With the reduction of volume of cement per m^3 (yd^3), the weight of cement per m^3 (yd^3) will be less and therefore the YCF (kg of cement/ m^3 [lb of cement/yd^3]) will be less than the Design YCF. When the measured percent air is lower than the design percent air, the converse is true and the Actual YCF is higher than the Design YCF.